Master project at CoaST, DTU Chemical Engineering

Title: Synergetic effect of fillers on the performance of hydrocarbon intumescent coatings

Period: 5 months

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Companies involved: Hempel A/S

Background

Structural steel is the most common material for construction projects. In the event of a fire, the temperature of steel increases rapidly due to its nature of high thermal conductivity. Structural steel only retains around 50% of its original strength when its temperature reaches a critical value and loses it bearing ability under full design load. This critical temperature is also known as ‘‘failure temperature’’, and the time for reaching it is called the “failure time”. An efficient way to protect the building structure and prolong the time before the failure temperature is reached is by intumescent coatings. At elevated temperature, intumescent coatings swell to a multicellular char layer, which acts as a physical barrier to slow heat and mass transfer and thereby protects the underlying substrate. Generally, intumescent coatings consist of three essential ingredients: acid source, carbon source, and blowing agent. Other additional fillers are incorporated into the formulation as well to improve its function.

Purpose of project

The purpose of the project is to evaluate the synergetic effect of fillers (e.g. ammonia polyphosphate and TiO_2, ammonia polyphosphate and zinc borate) on the fire-protection performance of the hydrocarbon intumescent coatings, using a lab-scale oven. Other equipment such as rheometer and thermogravimetric analyzer will be used for characterizing the rheological properties and thermal reactivity of the coatings. The focus is on investigating the synergetic (or competitive) relation between the reactions of ammonia polyphosphate and TiO_2, ammonia polyphosphate and zinc borate, and ammonia polyphosphate and cured epoxy, and the effect of this relation on the dynamic viscosity, thermal degradation, and fire-protection performance of the coating.

Content

- Literature review on the effect of fillers on the fire-resistance performance and char structure
- Manufacturing and application work of the hydrocarbon intumescent coatings
- Fire-protection experiments with the lab-scale oven in CoaST DTU and the assessment of thermal degradation and dynamic viscosity change of the intumescent coatings, and characterizations of the chars
- Link the synergetic effect with the fire resistance performance, char structure (dynamic viscosity, porosity), and composition of the residue.